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ABSTRACT

In fast speech, certain segments pronounced in careful speech may be deleted. Rules of a generative phonology have been used to account for fast speech forms. An alternative approach is suggested which views fast speech deletions as merely limiting cases of segment reduction, under conditions of increased tempo and/or casualness. To complement this approach, generative phonology rules should be adjusted and stated as phonetic realization rules. All segment reduction/deletions resulting from stylistic variation in speech should be specified in descriptive terms rather than in classificatory terms. The segment is then not explicitly deleted but rather is assigned a zero length. The descriptiveness of realization rules is necessary because the differences found in the lengths of the segments are gradational rather than abrupt and the outputs of such rules are not further subject to phonological rules of the language. Accounting for speech variation resulting from assimilation by phonetic realization rules must involve a more radical reappraisal of the form of such rules than is required to account for segment deletion. High-frequency amplitude Mingograf tracings and spectrograms reflecting variation in speech rate are provided. (Author/JK)

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A Note on Deletion Rules in Fast Speech*

Nigel Hewlett

Introduction

Among the differences between fast speech and careful speech[1] is that certain segments which are usually pronounced in careful speech may be deleted altogether in fast speech. Thus in English unstressed schwa may disappear entirely from the words *sickening, factory, support, career* in fast speech, and likewise the [t] or [d] may disappear from, for example, the words *hands, acts, mists, winds*. Furthermore, the fact that for example *sickening* is far more likely to undergo schwa-deletion than *picketing*[2] - despite the fact that [kt] is perfectly acceptable as a medial cluster in English (cf. *depicting*) - suggests that fast speech processes may not be explicable purely in phonetic terms.

The recognition that the differences between careful and fast speech are far from random (in fact the 'alternations' that are found between careful and fast speech forms are sometimes strikingly similar to those involved in conventional phonological processes[3]), together with the fact that no explanation for fast speech forms stated simply in terms of the mechanics of the speech production apparatus is (so far) available, has led to a growing body of phonological literature the concern of which is to account for fast speech forms in the rules of a generative phonology (see for example: Zwicky 1972, Algeo 1975, Rudes 1976, Bolozky 1977). In this literature a segment deletion of the type mentioned above is invariably to be accounted for by a rule which states that the segment in question is rewritten as zero under conditions of fast speech. Thus Zwicky's rule of Pre-Stress Contraction, repeated here as 1., would account for a deleted vowel in the first syllable of *support* and *career*.

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*I would like to thank Marcel Tatham, Linda Shockey and Ignacio Roca for their constructive criticisms of the ideas expressed in this note. I would also like to express my gratitude to Br. Peadar O Loinsigh for acting as informant for some Irish data, a small item from which is presented here.

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1. $[\emptyset] \rightarrow 0 \; / \; \# \; C - C \begin{bmatrix} +\text{stress} \\ -\text{cons} \\ +\text{voc} \end{bmatrix}$

In this note I wish to draw attention to a particular phonetic aspect of the nature of segment deletions in speech, and that is that phonetically speaking such deletions are merely limiting cases of segment reduction, under conditions of increased tempo and/or casualness. For example, some approximate upper limit could presumably be determined for the length of the first vowel in a word like *support*, a limit beyond which the pronunciation of the word would sound unnatural; and, at the other extreme, in fast speech the vowel may disappear altogether. However, and this is the point I wish to emphasise, in between these two limits any intermediate realisation of the vowel is possible. In the course of elaborating on this point I will suggest that rules of the kind quoted above may not be the best way of accounting for deletion in fast speech. An alternative, together with one or two consequences that might follow from it, will be suggested. This alternative amounts to the proposal that rules like Rule 1., above, should be adjusted so as to be stated as phonetic realisation rules, and that all processes of deletion in fast speech should be accounted for in the phonetic realisation rules.

The extension of this proposal to cover processes of fast speech assimilation as well as deletion, although desirable (in my opinion) is, however, problematic. I discuss this point briefly at the end of this note.

Segment Reduction and Segment Deletion

The assertion that segment reduction (including possible deletion) in fast speech is clinal in nature, rather than abrupt, is easily verified.

In a preliminary experiment, a subject was asked to read through a list of seven sentences, twelve times, carefully and distinctly. He was then asked to read through the same list another twelve times, but this time much faster. There were thus 24 versions of each sentence: 12 'careful' versions (ie. spoken under the instruction to speak carefully and distinctly) and 12 'fast' versions (ie. spoken under the instruction to speak much faster). One of the sentences was:

He didn't get much support.

In this sentence the length of the [ə] in *support* ranged between 30ms and 50ms, with an average length of 44ms, in the careful versions. In the fast versions the length of [ə] ranged from 0ms to 50ms (with instances of 10, 20, 30 and 40ms), with an average length of 24ms (complete deletion occurred in two cases). Another sentence was:

It's liable to mists.

In the careful versions of this sentence the length of the [t] in *mists* ranged from 0ms to 60ms (with instances of 20, 30, 40 and 50ms), with an average of 20ms, while in all of the fast versions the [t] was deleted.[4]

The gradational nature of segment reduction/deletion has received at best token acknowledgement in the literature (with which I am familiar) on speech variation. Leaving out of account intermediate possibilities between 'full presence' and 'complete absence' of a segment has encouraged phonologists to make categorical distinctions between 'careful' speech forms and corresponding 'fast' speech forms and to account for the latter by formulating a series of rules which take the careful speech forms as input (or more exactly the distinctive feature matrices which are supposed to underly these careful speech forms) and derive the fast forms from them.

Consider now more closely the consequences of this procedure when it comes to specifying the precise phonetic structure of a word like *support*. This word will have been liable to the Pre-Stress Contraction rule (Rule 1., above). Now since this rule is optional (or dependent on some such specification as [+ FAST SPEECH]), either its input (where the rule has not applied) or its output (where the rule has applied) will be subject to phonetic realisation rules. I take phonetic realisation rules to be rules which convert matrices of features specified in classificatory terms (mostly + or -) into matrices in which the features are specified in descriptive (numerical) terms and which form the input to an automatic phonetic component. The zero segment of the output of the Pre-Stress Contraction rule will not of course require phonetic realisation.[5] However, where the Pre-Stress Contraction rule has not applied the [ə] segment (which will of course be specified as a distinctive feature matrix) must form part of the input to phonetic realisation rules. Now the length of this segment is phonetically variable, and this variation will have to be accounted for by means of a phonetic realisation rule which describes the range of lengths permitted - I can see no other reasonable way of accounting for it. Let us consider how the length of this segment must be specified if we wish to account for the variation that was found in the experiment reported above in the length of the [ə] of *support*. It was found that the length of the [ə] ranged from 0ms to 50ms.

The two instances of complete deletion that were found are accounted for by the Pre-Stress Contraction rule; the remaining possibilities must be accounted for by a phonetic realisation rule, which might have a form something like that of Rule 2., below (for the sake of convenience I will assume that the variation found in this word is representative, for the environment of the Pre-Stress Contraction rule). This results in an absurd situation in which a phonetic realisation rule accounts for variation in the length of [ə] up to but excluding 0, and a phonological fast speech rule derives the forms in which [ə] is deleted altogether. Thus:

1. Pre-Stress Contraction:

$$[ə] \rightarrow 0 \;/\; \# \; C - C \begin{bmatrix} +\text{stress} \\ -\text{cons} \\ +\text{voc} \end{bmatrix}$$

2. Schwa Length Realisation:

$$[ə] \rightarrow [n \text{ ms long}] \;/\; \# \; C - C \begin{bmatrix} +\text{stress} \\ -\text{cons} \\ +\text{voc} \end{bmatrix}$$

$$\text{where } 50 \geqslant n > 0$$

An obvious alternative to consider would be that of accounting for all the observed length variation in the phonetic realisation rule, which might then be written in the form:

3. $$[ə] \rightarrow [0 \leftrightarrow 50\text{ms long}] \;/\; \# \; C - C \begin{bmatrix} +\text{stress} \\ -\text{cons} \\ +\text{voc} \end{bmatrix}$$

which is interpreted as meaning that [ə] may take any value for length between 50 and 0 ms inclusive, in the stated environment. A similar rule can account for the variation found in the length of [t] in *mists:*

4. $$[t] \rightarrow [0 \leftrightarrow 60\text{ms long}] \;/\; C - C \;\#$$

There remains the further possibility of adding to the rules in such a way as to link directly the particular value taken for length with factors such as 'speech tempo', 'casualness', etc. - but this must await more information on the precise relationship between variations in speech and the linguistic and extra-linguistic factors which condition them.

Realisation Rules and Deletion

The main proposal of this note, then, is that all segment reduction/deletions resulting from stylistic variations in speech should be accounted for by phonetic realisation rules; that is, they should be specified in descriptive terms rather than in classificatory terms. Such a requirement would serve to avoid the kind of unnecessary duplication exemplified above. I shall further argue that this method, which does not explicitly delete a segment but merely, in the limiting case, assigns it zero length, is more realistic in the phonological status (or lack of it) that it assigns to deletion processes resulting from speech variation; and that it suggests a way in which restrictions on the scope of application of surface phonetic constraints (SPC's) may be captured more naturally.

The precise phonetic form of the outputs of all phonological rules which are specified in discrete, classificatory terms will of course be subject to variation to a greater or lesser degree. Thus showing that there is a gradation of phonetic variation involved in processes described by rules of the form [segment] → 0. is not in itself quite sufficient to show that such processes should not be described in discrete, classificatory terms. For instance, take the case of a form in which a segment has been deleted (or even greatly reduced) and which then becomes subject to a regular phonological rule or constraint from which the corresponding unreduced form is exempt (or vice versa). In this case there would be some motivation for making a categorical distiction between the presence and absence of the segment in question, according to whether or not the form underwent the subsequent rule, and regardless of the gradational nature of the differences in phonetic form.

However, where two segments find themselves adjacent as the result of a deletion in fast speech they do not, characteristically, become obligatorily subject to any rules, or 'surface phonetic constraints' (SPC's) (Shibatani 1973), specified by the phonology of that language for two such adjacent segments. Further phonetic evidence for this observation is provided by the results of the experiment referred to above. In a second part to this experiment the same subject was asked to read a second set of sentences, with the same instructions. In the examples given below, the (a) sentences are from the first set and the (b) sentences are from the second set:

5. (Ia) *It's liable to mists.*
(Ia) *It's liable to miss.*
(IIa) *He didn't get much support.*
(IIb) *He didn't get much sport.*
(IIIa) *There were lots of people but only one parade.*
(IIIb) *There were lots of people but only one prayed.*

Now where *mists* was pronounced [mIss] this violated the phonological constraint for English which proscribes a sequence of adjacent sibilants. There was no obligatory rule operating, for example, to convert the sequence of two [s]'s into a single [s]; thus *mists* [mIss] in the (a) sentence was distinguishable from *miss* [mIs] in the (b) sentence.[6] As regards *support*, in (IIa), there is a low-level rule in English to the effect that syllable-initial /p/ is aspirated whereas /p/ following initial /s/ is not. Now it was noticeable that in the fast versions of the sentence, where the [ə] tended to be reduced, the length and aspiration of the /p/ were relatively unaffected by the increase in tempo, including the two instances in which the [ə] was deleted entirely. In these cases, then, the phonetic form of *support* was [spʰɔ:t], in violation of the aspiration rule, and distinct from *sport* in the (b) sentence in the quality of the /p/. There was a similar result as regards the quality of the /r/ in the two words *parade* and *prayed* in (IIIa) and (IIIb), respectively. In the careful versions of the (a) sentence *parade* was consistently pronounced [prejd], with a syllabic [r̩]. In the fast versions the length of the /r/ was greatly reduced but, as spectrographic analysis revealed, at least a portion of it remained voiced, in contradistinction to the /r/ of *prayed* which was pronounced [prejd], with voiceless [r̥], in conformity with the rule of English which devoices /r/ and /l/ after an initial voiceless stop.

No obligatory phonological rules, then, appear to follow as a result of deletion in fast speech, even where such deletions result in a violation of the SPC's. Indeed one might say that where a fast speech deletion violates a SPC this is advantageous as far as the listener is concerned since it increases the chances of phonological 'recoverability'. The mechanism under proposal also provides for a more natural way of distinguishing between those feature matrices which are subject to the SPC's and those which are not (at least to the extent that SPC's are violated by processes of deletion, as against assimilation). In other models this can be done either by allowing the SPC's to apply only to the output of the phonological cycle deriving careful speech forms (Rudes 1974) or, where fast speech forms are derived within a unitary phonological component, by blocking the operation of the SPC's where appropriate, in the derivation of fast speech forms (as proposed by Bolozky 1977).

Under the present proposal, however, since SPC's are stated in classificatory terms they will apply only to the classificatory output of the phonology (ie. they will apply immediately before the realisation rules[7]). Classificatory matrices will be 'above' any particular style of pronunciation. Once the realisation rules have started to apply the SPC's cease to be relevant. Thus the distinction between matrices which are subject to SPC's, and those which are not, is well motivated. SPC's represent constraints only on classificatory matrices; they obviously have a phonetic basis, but they are essentially statements about the resulting structure of contrasts and neutralisations in the language once all the phonological reules have applied. They are not valid as descriptions of actual pronunciation, since in actual speech (so-called careful, or not) many of them are probably broken most of the time.

A Morphophonemic Deletion Rule in Irish

I have argued that fast speech reduction/deletion rules should be phonetic realisation rules; that is, the feature specifications should be descriptive rather than classificatory, because (i) the differences found in the lengths of the segments in question are gradational rather than abrupt, and (ii) the outputs of such rules are not further subject to regular phonological rules of the language. For the sake of comparison, it might be worth considering a morphophonemic syncope rule about which there is little doubt but that it should be stated in classificatory terms. Irish has a rule which deletes an unstressed vowel in the last syllable of a morpheme of more than one syllable when a following inflection begins with a vowel. The deletion occurs in the comparative of certain adjectives and in the genitive and plural of certain nouns. Thus:

6.

obair [obIr$^{\prime}$] work	*oibre* [obr$^{\prime}$ə] work (gen.)
iseal [iʃəl] low	*isle* [iʃ$^{\prime}$ə] lower
leitir [let$^{\prime}$Ir] letter	*letreacha* [let$^{\prime}$rʲəxə] letters

This rule is obligatory, and (so far as I can tell) there are no acceptable intermediate stages between occurrances and deletion in the forms in the right hand column. Indeed it is quite conceivable that vowel deletion is an important perceptual cue that the plural (genitive, comparative) is intended. More importantly, after vowel deletion the resulting forms may be subject to further rules. Thus, Irish has contrasting sets of palatalised (symbolised by ' in the transcription above) and velarised consonants. Whereas the /b/ in *obair* is velarised, after vowel syncope

has taken place for *oibre* it must undergo palatalisation to agree with the following palatalised /r'/; and similarly with the /l/ in *iseal* (Dillon and O Croinin 1961). The quality of the /t/ also alternates in *leitir* and *letreacha*. Intervocalically, in *leitir*, the /t/ is slightly fricative; in *letreacha*, however, it is definitely occlusive. The fact that the output of a vowel deletion rule must undergo a subsequent rule whose structural description specifies two adjacent consonants (which were formerly separated by the vowel) testifies to the phonological and psychological reality of that (deletion) rule, and suggests that the rule should be stated as a genuine phonological alternation. In this case, in contrast to the fast speech deletion rules described above, there may be a phonetic realisation rule to take care of any variation there is in the length of the second vowel in the forms in the left hand column in 5.; but in addition there must be a phonological rule deleting that vowel in order to account for the morphophonemic alternation.

Saving on Rules

Notice also that under this proposal all stylistic variations involving segment length - those of 'careful, 'fast', 'casual', etc. speech - can be derived from the same input by the same 'variable' realisation rules, such as 3. and 4., above. This avoids, at any rate for deletion rules, a somewhat disconcerting aspect (pointed out by Hooper 1976:114) of those treatments of fast speech which derive fast speech forms by rules from careful speech forms: namely that the less careful variants require a greater number of rules than the more careful variants. Hooper attempts to answer this objection, and defend models such as that of Rudes (1976), by arguing that since phonetic realisation rules are required in order to derive even those forms which do not undergo any other phonological rules, therefore in reality fast speech forms do not undergo a greater number of rules than careful speech forms. Thus she says (and the nature of this quotation will lead us on to a final brief consideration of assimilation rules):

> 'It is important to remember, however, that in reality it takes the same number of rules to derive [ti] from /ti/ as to derive [č̃i] or [č̃] from /ti/.' (114)

But this is not true if [č̃i] is to be derived from /ti/ by a rule specified in classificatory terms, such as:

7. $\begin{bmatrix} +\text{stop} \\ +\text{coronal} \end{bmatrix} \rightarrow [+\text{palatal}] \; / \; - \begin{bmatrix} +\text{vocalic} \\ +\text{palatal} \end{bmatrix}$

since in this case only the phonetic realisation rules are required to derive [ti], whereas to obtain [ʧi] the underlying form /ti/ must undergo the palatalisation rule and then the phonetic realisation rules. It would only be true if the classificatory matrix for /ti/, whose essential features are given by Hooper as:

8. $\begin{bmatrix} +\text{stop} \\ +\text{coronal} \end{bmatrix} \begin{bmatrix} +\text{vocalic} \\ +\text{palatal} \end{bmatrix}$

was operated upon directly by two alternative phonetic realisation rules, one of which produced the relevant phonetic specifications for [ti] and the other the relevant specifications for [ʧi] - or, if there was a gradual progression from [ti] to [ʧi], a 'variable' realisation rule of the sort exemplified above for segment deletion. The problem here would be that in addition to the specifications [+stop, +coronal] the stop segment is also classified as [-palatal]; in deriving [ʧi], therefore, the phonetic realisation rule would have to give articulatory/acoustic specifications associated with the palatal region for a segment with the classificatory specification [-palatal], which would be a strange state of affairs.

Judging by the remarks following immediately on from the above quotation, it may well be that Hooper intends all speech variation to be captured directly as variation in phonetic realisation (as I have argued that segment deletions, at any rate, should be), which, in my view, would be desirable; and her characterisation of the nature of the variation between [ti] and [ʧi] is thoroughly convincing. But it is not the case that any existing formalism (that I know of) captures it.

> 'More casual styles of speech do not derive from the application of more rules but merely from the modification of rules. Even the progression of [ʧi] to [ʧ] ... does not really represent the addition of a deletion rule; it represents the ultimate stage in the regressive timing of the palatal vowel: the palatal articulation of the vowel occurs simultaneously with the articulation of the consonant and is no longer a separate gestures.' (114)

Clearly, accounting by phonetic realisation rules for speech variation resulting from assimilation must involve a more radical reappraisal of the form of such rules than is required to account for segment deletion.

Footnotes

[1]I use these terms for convenience. In fact the precise relationship between speech rate (and other factors) and the variations that are considered here must be quite complex, and will certainly vary from one speaker to another. The focus of this note is on the observed variations themselves rather than the factors that condition them.

[2]This example is from Algeo (1975).

[3]For example, the morphophonemic alternation in Irish which is described below appears quite similar to the vowel deletion in words like *sickening* and *factory*.

[4]The length of the [t] in *mists* was measured, somewhat arbitrarily, as the duration of the fall in high frequency activity below 3.3kHz. Where the trough between the high frequency peaks representing the [s]'s remained above 3.3kHz, this could be interpreted either as a case of progressive lenition of the [t] in between the two [s]'s, or as a case of rearticulation of [s]. I chose the latter interpretation in order to simplify the statement of the rule; however, the question of which interpretation is correct must in the end by an empirical one. On the question of rearticulation, the 'phonetic reality' of which has been disputed, see Lehiste, Morton and Tatham (1973), and the references cited there.

[5]Note however that there must at least be a universal convention to handle the phonetic interpretation of strings containing a null segment.

[6]In one of the 'fast' versions of *It's liable to mists* the Mingograf reading shows a very shallow trough between the two peaks of high frequency activity representing the sequence of [s]'s at the end of *mists* (see Footnote 4). It seems possible that further reduction might occur along the lines: [ss]→[s:]→[s]. I assume, however, that this must be accounted for as a further fast speech process, rather than a sudden change of heart about breaking a phonological constraint. (A similar kind of progression might be possible with respect to other examples given here, as well.)

[7]Anderson (1975) argues that there are cases where a 'phonetic detail' rule must precede a rule expressed in classificatory terms. Where such a phonetic detail rule was expressed in descriptive (numerical) terms, as some at least are intended to be, this of course would invalidate, or at least seriously complicate, the convention regarding the application of SPC's proposed here. However, I think it unlikely that precise phonetic detail can depend on abstract features in the way in which Anderson suggests. One of Anderson's examples, for instance, concerns the ordering of vowel

lengthening rule and the flapping rule for words like *rider* and *writer* in (some dialects of) American English. Anderson argues that vowel lengthening must precede flapping, a position which is supported with phonetic evidence in Fox and Terbeek (1977). Anderson further argues that vowel lengthening must be expressed in numerical terms. However, while Fox and Terbeek show that the difference in vowel length before a flap derived from a voiced consonant and a flap derived from a voiceless consonant is (statistically) significant, they also find that 'all pre-flap vowels fall within the range of short vowels' (34). In other words the degree of vowel lengthening observed is that for the environment before a flap derived from a voiced consonant, rather than before a voiced consonant. Therefore no correct numerical specification for vowel length could be given without taking flapping itself into account.

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Fig.1

Fig.2

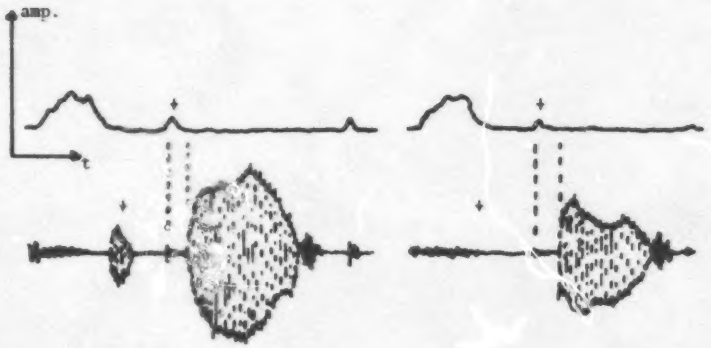
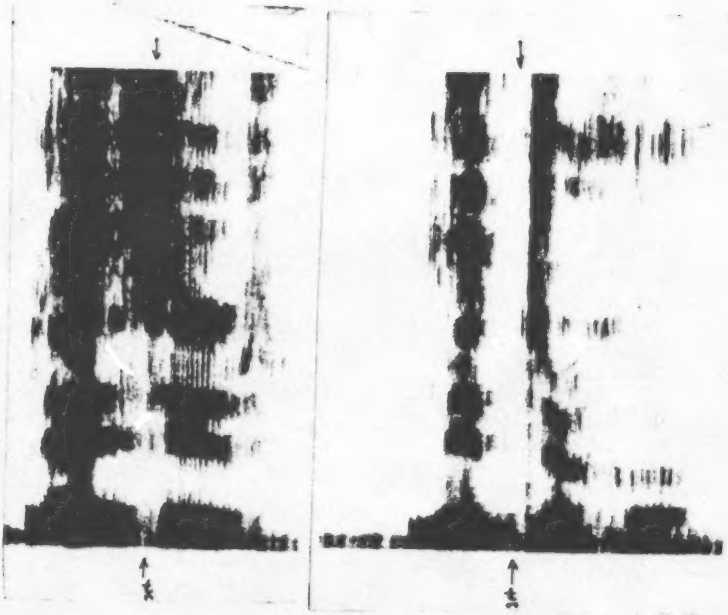


Fig.3

Fig.4

Figures 1 and 2 show high-frequency amplitude Mingograf tracings (high-pass filter set at 3.3kHz) of the final consonant cluster in *mists* in two readings of the sentence *It's liable to mists*, by the same subject. Figures 3 and 4 show the audio waveform and a high-frequency amplitude tracing for the word *support* in two readings of the sentence *He didn't get much support*. Arrows indicate the segment which has been deleted in 4, and the aspiration at the release of /p/. [The waveforms have been retouched for reproduction purposes.]



leitir *leitracha*

Spectrograms of *leitir* and *leitracha* showing the fricative quality of [t̠] in *leitir* as compared with complete stop closure in *leitracha*, as pronounced by a native speaker of Irish.